iron, mixed with a portion of argill. Its appearance altogether might easily induce mineralogists to refer it to that kind which has been distinguished by the name of Arragonite; but various reasons are here assigned for considering them as distinct substances. Chemical analysis has not yet afforded any criteria for distinguishing this species either from the arragonite or the common carbonates of lime. And it is lastly thrown out, merely as a conjecture, whether its greater degree of hardness and specific gravity may not be owing merely to its constituent particles being more minute and more closely connected.

The second part of this paper, which treats of a new species of oxide of iron, is prefaced by a short survey of the different appearances of the oxides of iron, according to their various degrees of combination with oxygen: and it is here suggested, that not only the proportion of oxygen, but also the mode of combination, may contribute to produce varieties which cannot by any other means be accounted for. The new species here described is thought to hold its place between the slightly attractable oxide of iron called Specular ore, or, by Abbé Hauy, *fer oligiste*, and that kind which no longer crystallizes except in a very indeterminate form. Its surface is of a gray colour, and has a specular appearance: it is not at all acted upon by the magnet, and seems to be the last degree of oxidation in which iron retains the property of crystallizing in a regular form. This form is a perfect cube; its fracture is conchoidal; its hardness is rather inferior to that of the slightly attractable oxide of iron; its specific gravity only 3961.

To this species it seems ought to be referred the *Eisen-glimmer* of the Germans, when it is not attractable. When at all acted upon by the magnet, it ought to be numbered among the slightly attractable oxides of iron. Specimens of this new species have been brought from Lapland, and are often found mixed or embodied in other oxides of the same metal.

The author, lastly, points out how, by the red colour of the powder and by scratching, this species may be, in a general way, distinguished from the others; an object of no trivial importance, since the products of metal from the ores may be influenced by this discrimination.

Account of the Changes that have happened, during the last Twenty-five Years, in the relative Situation of Double-stars; with an Investigation of the Cause to which they are owing. *By* William Herschel, *LL.D. F.R.S.* Read June 9, 1803. [*Phil. Trans.* 1803, *p.* 339.]

After some general observations on the various discoveries lately made, which have contributed to extend our knowledge of the construction of the heavens, Dr. Herschel assumes as a possibility, that among the multitude of the stars in the firmament, there may be instances of pairs of stars of the same or different relative magnitudes, which may revolve, either in circles or ellipses, round their common

centre of gravity. Having started this hypothesis, he proceeds to give an account of a series of observations on double stars, comprehending a period of twenty-five years, which, in his opinion, will go to prove, according to the above assumption, that many of them are not merely double in appearance, but must be allowed to be real binary combinations of two stars, intimately held together by the bond of mutual attraction.

In this inquiry, three bodies or points are to be exclusively attended to:—1st, the largest of the two stars which make up the double star; 2nd, the smaller of these two stars; and 3rd, the place of the sun, which at the great distance of the fixed stars may be taken for that of the observer. It is obvious, that as this investigation must be conducted in an hypothetical manner, it is necessary to consider the appearances that would be produced by the motion of these three bodies, either singly, by pairs, or collectively. This renders it necessary to contemplate a variety of cases, and previously to lay down a certain theory to which the observations may be referred upon the supposition of either of those cases. For this purpose the author has drawn up tables, showing the appearances as to distance and angle of position that must result from the motions of either of those three bodies, whether in right ascension or declination.

As the number of double stars in which he has ascertained manifest changes in their relative positions amount already to more than fifty, our author thinks it advisable to confine himself in this paper to only a few of those instances; and, accordingly, we find here an investigation of the changes of six double stars, viz. α Geminorum, γ Leonis, ε Bootis, ζ Herculis, δ Serpentis, and γ Virginis; reserving himself to treat of the others in a future paper.

His observations on the double star α Geminorum commenced so long ago as the year 1779, and have been regularly continued to the present time. In this interval of twenty-three years and a half, the distance of the two stars has not varied, being constantly about two diameters of the large star; but the angle of position has altered considerably. In the year 1779 it measured 32° 47′ north preceding; and by the last observation in the present year it is now only 10° 54′; so that in the space of twenty-three years and a half it has manifestly undergone a diminution of no less than 21° 54′: and the intermediate observations leave no room to doubt that this change has been the effect of a gradual and regular motion.

A revolving star, it is evident, would at once explain such a progressive change in the angle of position, without an alteration of the distance; but this being a supposition of which we have not hitherto any precedent, it ought certainly not to be admitted without the fullest evidence. Accordingly, our author enters into a minute examination, founded on geometrical and optical principles, whether the above-mentioned phænomena cannot be satisfactorily explained by other motions of the stars or of the sun, according to the several hypotheses above indicated, with the addition of others in which the two stars are not supposed to be at equal distances from the sun.

Each of these hypotheses having been carefully investigated, it is found that all except that of a rotatory motion of the small star round the large one, or of their joint motions round a common centre of gravity, offer difficulties which cannot be surmounted. Adopting, therefore, this last-mentioned hypothesis as the true one, our author proceeds to a more detailed examination of the several angles of position he has taken in the course of his observations; and having also determined those angles by calculation from the annual rate of 56′ 18″, deduced from the total change in the whole period, he finds the agreement so obvious as hardly to admit of a doubt of this being the true mode of accounting for these variations. He has, moreover, the satisfaction of being able to quote an observation of Dr. Bradley, made in the year 1759, which he lately obtained from Dr. Maskelyne; according to which, the two stars of α Geminorum were in that year seen in an angular position, exactly corresponding with the situation they ought to have been in, according to the rate here assigned for their rotatory motion: so that the time of a periodical revolution may now be calculated from an arch of 45° 30′, which has been described in forty-three years and a half.

Thus, from the great regularity of this motion, he now thinks himself authorized to conclude, that the orbit in which the small star moves round the large one, or perhaps the orbits in which they both move round their common centre of gravity, are nearly circular, and at right angles to the line in which we see them; and that the time of a whole apparent revolution will be about 342 years 10 months.

We shall not presume to enter here upon any detail of the investigations respecting the five other double stars mentioned in this paper, any further than to record the general results deduced from them.

In γ Leonis the plane of the orbit of the small star is found not to be at right angles with the line of vision, the distances having varied considerably since the commencement of the observations, and these different distances affording the elements of an ellipsis which will explain the appearances, although the orbit be in fact, or nearly, circular. The periodical time of this revolution is calculated at about 1673 years.

As to ε Bootis, the changes observed during twenty-two years indicate that one of the periodical revolutions cannot take up much less than 1681 years; but as the figure and situation of the orbit cannot as yet be accurately determined, some uncertainty still remains even concerning this period.

The observations on ζ Herculis afforded a phænomenon hitherto unknown in astronomy; namely, an occultation of one star by another. Whether this be owing to solar parallax, to proper motion, or to the motion of one of the stars in an orbit whose plane is nearly coincident with the visual ray, is not as yet determined; nor is any periodical time hitherto assigned to it.

The periodical time of δ Serpentis is calculated at 375 years, and that of γ Virginis at 705 years. Their distances have not varied for

many years back; whence it may be inferred that the planes of their orbits are really or nearly at right angles with the visual ray.

Dr. Herschel being aware that the observations he brings forward in this paper are of a nature so delicate and minute as to afford opportunities for cavil, has been at considerable pains to point out the principal circumstances that contribute to the perfection of telescopes and micrometers, and the precautions to be used as to the state of the atmosphere. Those ought, he thinks, to be particularly attended to by accurate observers.

An Account of the Measurement of an Arc of the Meridian, extending from Dunnose, in the Isle of Wight, Latitude 50° 37′ 8″, *to Clifton, in Yorkshire, Latitude* 53° 27′ 31″, *in course of the Operations carried on for the Trigonometrical Survey of England, in the Years* 1800, 1801, *and* 1802. *By Major* William Mudge, *of the Royal Artillery, F.R.S.* Read June 23, 1803. [*Phil. Trans.* 1803, *p.* 383.]

In this paper we are presented with a further continuation of the several accounts given, ever since the year 1785, of the trigonometrical surveys carried on over various parts of the kingdom. Having now proceeded a great way in these surveys, Major Mudge thought it high time to attempt the measurement of a considerable arc of the meridian in our latitudes. He first assigns his reasons for preferring the meridian he has here adopted, which depend chiefly on the nature of the country being less hilly and liable to less obstruction than any other tract of the length of this arc in the island. He fixed on Dunnose, in latitude 50° 37′ 8″, for the southern extremity, and on Clifton, a small village in the vicinity of Doncaster, latitude 53° 27′ 31″, for the northern termination of this arc: and near the latter place he found a convenient plain, viz. Misterton Carr, for the measurement of a base of verification.

As the accuracy of the zenith observations would be most essential towards the perfection of this measurement, a new zenith sector was constructed for the purpose by Mr. Ramsden, and finished by Mr. Berge, the excellence of which is here attested by its being called the first instrument of its kind. Its merits consist chiefly in the means of uniting the sectorial tube to its axis, so as to insure the permanency of the length of its radius when erected for observation; in a more accurate method of adjusting the instrument vertically; an easy way of placing the face of its arch in the plane of the meridian; and a contrivance by which the plumb-line can be brought precisely over the point marking the centre of the circle, of which the divided arch of the sector should be a part.

Having given a minute description of this instrument, and of the preparatory operations for the series of observations to be made with it, such as the construction of a proper observatory, and other auxiliary requisites, the author proceeds to give us, in different tables,